METHOD OF MAKING AN EDGE-FLOW RESISTANT LAMINATE

Technical Field

The present invention is directed toward improving the production of reinforced and non-reinforced laminates. More specifically, the present invention is directed toward an improved method of producing conveyor belting and other similar laminates comprising one or more layers of material.

Background Art

Conveyor belting, such as that illustrated in FIG. 1, is typically comprised of multiple layers of reinforcement between layers of non-reinforcing material. The reinforcing plies are formed of any conventional reinforcing materials, and are typically calendered with a coating of rubber prior to being used in the belting construction. The non-reinforcing plies are typically formed from rubber, PVC, or the like. The non-reinforcing plies may also be formed from fiber-loaded elastomers, conventional thermoplastics, or thermosets. At a minimum, the belt has at least one elastomeric layer. The thickness and width of the belting varies depending upon the end-use of the belting and the thickness of each layer.

Prior to curing of the laminate, the layers of the laminate are unrestrained, except for any adhesion between the layers due to the green tackiness. The layers may shift relative to another between building and curing. During the cure process, the sides of the laminate may be restrained by means of mechanical assistance, such as steel, aluminum, or rubber edge guides, or the sides of the press. This method of restraining the edges of the laminate is cost and labor intensive, as a different size guide is required for each different gauge laminate produced, and the guides must be manually changed every time a different gauge is to be cured.

Due to the ability of the layers to shift and the curing rubber to flow, the edges of the laminate can become uneven and must be trimmed away in a post-cure operation. To compensate for this material flow and maintain the desired laminate gauge or weight, the rubber gauge of the reinforced layers and the elastomeric layers may be increased.

The increased rubber content due to the compensating increased gauge of the layers and the resulting scrap material from trimming the belts, as well as the additional cutting step, increases the cost of manufacturing the belting laminate.

Arnold, in U.S. Patents 5,326,411 and 5,423.165 discloses protecting the edges of belting. A wrap of fabric is affixed to the longitudinal edges of the core of the belt. The belt core is then provided with an encapsulating outer cover layer. Arnold fails to teach manufacturing the belting in a manner to reduce scrap and to provide for a more even cured belt edge.

Edge protection of materials is desired in many different technology fields. US Patent 5,624,735 discloses protecting the edges of a sheet molded compound article with a powder coating edge primer. US Patent 4,356,053 also discloses modifying the edges of a laminate to protect the inner layers of the laminate by forcing the edges of the outer layers about the edges of the inner layers.

Also, in the manufacture of rubber sheets for gaskets, it has been known in the art to apply a rubber cement fabric strip to the edges of a rubber sheet prior to curing to prevent the material from unrestrained flow during curing of the single non-reinforced sheet and make handling of the sheets easier for the operator. However, the restraining tape was permanently bonded to the rubber sheet, resulting in laminate edges that were selvage edges that could not be used for a finished product.

The present invention is directed toward overcoming the limitations of the above disclosed manufacturing methods.

Summary of the Invention

The present invention is directed toward an improved method of manufacturing a curable laminate that is plastically deformable until cured. The laminate is comprised of at least one layer. The layer may be a single reinforced sheet or a single thermoplastic or thermoelastic sheet. The laminate may also be formed of as many layers as desired by the manufacturer, depending upon the end use of the laminate. The method comprises layering the at least one layer to form an uncured laminate, modifying at least one of the longitudinal edges of the uncured laminate to prevent plastic deformation of the longitudinal edges during curing of the laminate as a whole, and then curing the laminate. One aspect of the improvement in the method is characterized by modifying one of the longitudinal edges by at least partially precuring the edge to convert it from a plastically deformable material to a thermoset material. In another aspect of the disclosed invention, a restrictive and removable material is applied to the longitudinal edge of the laminate during at least a portion of the curing of the laminate.

In the present invention, the restrictive and removable material may be a tape-strip or a preformed material. The tape-strip material is selected from the group consisting of a film strip, foil strip, textile strip, mesh strip, or any combination of these materials. The pre-formed material is selected from the group consisting of film, foil, mesh, plastic, or any combination of these materials. The pre-formed material has an overall configuration corresponding to the configuration of the longitudinal edge of the uncured laminate.

In one aspect of the invention, the restrictive and removable material is removed following curing of the laminate.

Brief Description of Drawings

The invention will be described by way of example and with reference to the accompanying drawings in which:

FIG. 1 illustrates the multiple layers of a conventional conveyor belting;

FIG. 2 is an asymmetrical view of the belting as the edges are being modified;

FIG. 3 is a cross sectional view of the belting after modifying the longitudinal belt edges;

FIG. 4 is an asymmetrical view of the belting after curing; and

FIG. 5 is a cross-sectional view of the belting after curing.

Detailed Description of the Invention

As previously discussed, FIG. 1 illustrates an exemplary conventional belting laminate 10. The illustrated laminate 10 is comprised of three reinforcing layers, 12, 14, and 16. Non-reinforcing layers 18, 20 are inserted between the reinforcing layers 12, 14, 16. Outer cover layers 22, 24 are provided on both sides of the laminate 10. The laminate 10 may be formed of less than the illustrated seven layers 12, 14, 16, 18, 20, 22, 24; the minimum being one layer. The selection of materials for the layers 12-20 is within the skill of persons knowledgeable in the belt making art. Exemplary reinforcing materials for the reinforcing layers 12, 14, 16 include nylon, polyester, rayon, aramid, steel, metallic fibers, glass, and combinations of these materials,; the reinforcing materials may be monofilaments or cord, depending upon the desired characteristics of the laminate 10. Synthetic rubbers and natural rubber are commonly used elastomers for the non-reinforcing layers 18, 20 and the cover layers 22, 24. Thermoplastic polymers having flexibility suitable for the end application may also be used as well. Illustrative of such materials is ethylene-propylene copolymers mixed with polypropylene, polyvinylchloride, nylon, etc.

During manufacture of the laminate 10, the multiple layers 12, 14, 16, 18, 20, 22, 24 are laid up together to form a laminate of uncured layers. This process may be completed by any one of several known lay-up methods, including a build table using rolls of pre-calendered material or a calendering together of the different rolls while the elastomeric layers are directly extruded onto the reinforcing layers. The choice of build method for the uncured laminate would be an obvious manufacturing choice to those of ordinary skill in the art.

After the uncured laminate is prepared, the individual layers of the uncured laminate 10 have the ability to shift relative to one another, and during curing, have the ability to plastically deform past the defined longitudinal edges 26, 28 of the laminate, as previously discussed. To restrain the longitudinal edges 26, 28 of the uncured laminate, the longitudinal

edges 26, 28 of the laminate 10 are modified in a manner in accordance with the disclosed invention.

After the lay-up of the uncured laminate 10 is complete, at least one of the longitudinal edges 26, 28 of the laminate are modified. In a preferred embodiment, a restrictive and removable material 30, such as a tape-strip 30, is wrapped about the longitudinal edges 26, 28 of the laminate 10. The tape-strip 30 can be a film, foil, textile, mesh, or combination of these, examples being nylon, polyester, metal, or dipped or undipped fabric. An adhesive or mechanical fastening system may be used to hold the tape to the laminate. If an adhesive is applied to one side of the tape-strip 30 in order to maintain the tape-strip's position on the laminate 10, then the adhesive should be of a type that does not bond with the laminate 10 during curing of the laminate 10.

The tape-strip 30 at each longitudinal edge 26, 28 extends across the width W of the laminate 10 a lateral width D, see FIG. 3. The lateral width D of the tape-strip 30 is individually selected as needed to restrain the flow of the laminate 10 during the curing process. Factors that determine the width D include the laminate thickness and the type of material being cured. The type of material being cured includes factors such as the material viscosity during cure, the needed cure temperature and the needed cure pressure. For conventional laminate materials, and conventional belting materials, the lateral width D is equivalent to about 1/1000 to 1/4 of the width W of the laminate 10. The thickness of the tape, t, may also vary as needed to prevent the tape 30 from bursting during the curing process.

After one or both edges 26, 28 have been wrapped, the laminate 10 is then cured to form a belting laminate 10. After curing, the tape-strip 30 may be either stripped from the laminate 10 as illustrated in FIG. 4, or may be left to form an integral part of the laminate 10. Due to the restraining effect of the tape-strip 30, the longitudinal edges 26, 28 are substantially aligned in the manner as intended when the uncured laminate 10 was laid up, see FIG. 5.

An alternative to applying a tape-strip 30 to the laminate edges 26, 28 is to pre-cure the laminate edges 26, 28. Again, the distance D selected is dependant upon the amount of edge restraint required to restrain the flow of the laminate 10 during the full curing process. The same factors that affect the width D the tape-strip 30 extends across the uncured laminate 10 are also relevant in determining the width of the pre-cured portion of the laminate edges 26, 28. The edges 26, 28 of the laminate 10 are cured to a lateral width D equivalent to 1/1000 to 1/4 of the width W of the laminate 10, similar to the distance disclosed above. The

temperature at which the edges 26, 28 are pre-cured will depend on the particular materials being used in the laminate 10.

Other alternatives to using a tape-strip 30 or precuring of the longitudinal edges 26, 28 is the use of a pre-formed edge piece 30. As the pre-formed piece has the same configuration as the tape-strip 30 after the tape-strip 30 has been applied to a longitudinal edge 26 or 28 of the laminate 10, the same reference numeral will be used to refer to the pre-formed edge piece. The pre-formed piece 30 has an overall U shape with the legs extending across the cover layers of the laminate 10. The pre-formed piece 30 can be a film, foil, mesh, plastic, or any combination of these, so long as the pre-form piece 30 is able to maintain or return to its pre-formed U shape. The pre-formed piece 30 may also be formed as a lightweight metal construct wherein a lightweight metal foil is directly shaped about the longitudinal edges 26, 28 of the laminate 10. Suitable adhesives that temporarily maintain the piece on the laminate 10 may be applied to the side of the piece 30 that contacts the uncured laminate 10. Other ways of mounting the piece 30 to the uncured laminate 10 include forming the legs of the piece 30 a distance apart just less than the thickness of the laminate 10 so the piece 30 is snug about the laminate longitudinal edges 26, 28. Also, small prongs may be provided at the edges of the piece 30 to bite into the outer covers of the laminate 10 and hold the piece 30 onto the laminate 10 until the laminate 10 has been cured.

By modifying the edges 26, 28 of the laminate 10, the previously discussed benefits and the following benefits, or any combination of the discussed benefits may be realized. The edge porosity of the laminate 10 is reduced or eliminated. The overall laminate gauge is improved, as discussed above. There is improved width variation of the uncured product prior to curing; that is the different layers 12, 14, 16, 18, 20, 22, or 24 of the laminate 10 are hindered from shifting, so that the uncured product more closely resembles the uncured laminate 10 as designed by the engineer.

Variations in the present invention are possible in light of the description of it provided herein. While certain representative embodiments and details have been shown for the purpose of illustrating the subject invention, it will be apparent to those skilled in this art that various changes and modifications can be made therein without departing from the scope of the subject invention. It is, therefore, to be understood that changes can be made in the particular embodiments described which will be within the full intended scope of the invention as defined by the following appended claims.